

The Rice University CCD Imager for the AEOS Telescope

Ian A. Smith

Reginald J. Dufour

Edison P. Liang

Jeffrey M. Silverman

(Rice University)

Larry C. Hardin

Robert D. Forgey

(Hardin Optical Company)

Mark A. Skinner

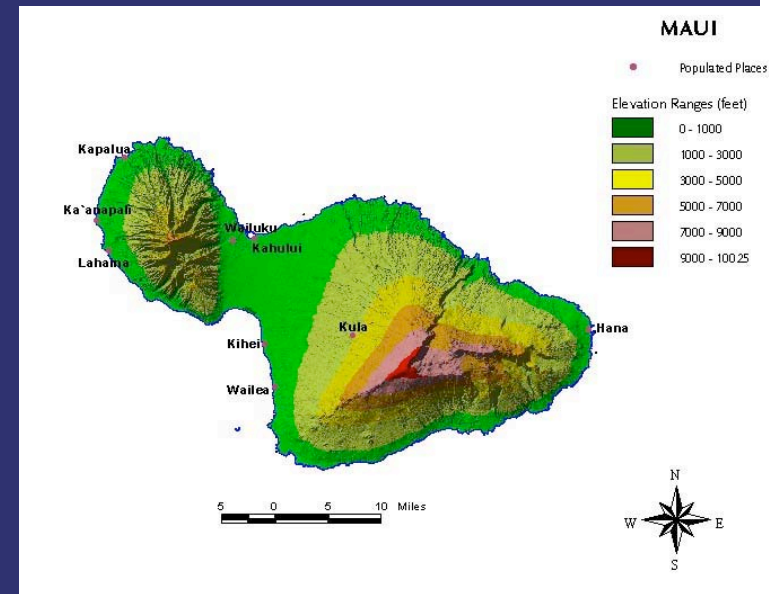
Spence Ah You

(Boeing LTS, Inc.)



Where is the AEOS Telescope?

- *Maui, Hawaii*
- *Haleakala volcano*
- *20.7 degrees N*
- *156.3 degrees W*
- *10,023 feet (3058 m)*
- *Site has similar advantages to Mauna Kea, although it is not as high*



Site



- *Part of the Maui Space Surveillance System*
- *Owned by the U.S. Air Force*
- *AEOS is the largest telescope owned by*



AEOS Telescope

- 3.63 meter Advanced Electro-Optical System (AEOS)
- Works in optical, near-IR, and mid-IR



Strength: Rapid Slewing

- *Telescope: 120 tons*
- *17.6 degrees/sec in azimuth*
- *4.75 degrees/sec in elevation*
- *Entire dome is lowered before operations*
- *Accurately tracks rapidly moving objects from horizon to horizon*
- *Expect to be on-target – anywhere in the sky – and*



What is it used for?

- *Tracking missile launches*
- *Identifying new satellites*
- *Monitoring satellite health/re-entry*
- *Identifying and tracking asteroids*
- *In essence, finding new objects rapidly, and studying their optical and infrared properties*



Rice University CCD Camera (RUCCD)

- *The RUCCD is a flexible instrument designed for GRB studies, particularly of the early emission*
- *When installed, it is always thermoelectrically cooled and ready to take data*
- *Minimum exposure time: 20 milliseconds*
- *$V = 23$ in < 1 minute*



Installing the RUCCD

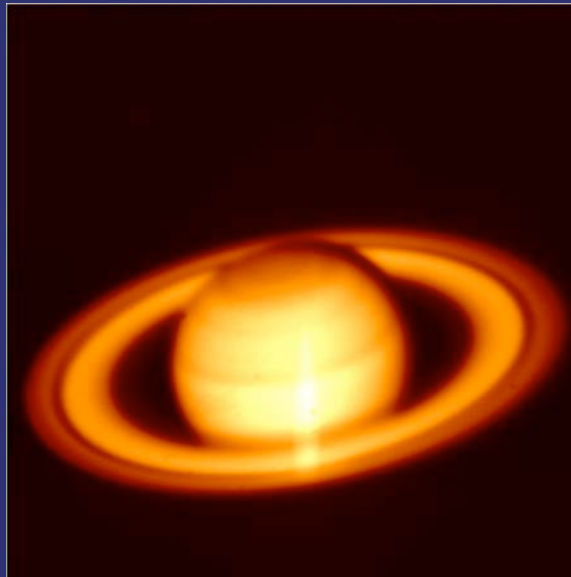


- *First light was obtained 2004 February 3 - 4*
- *We have been certified to perform GRB ToO observations with a high priority override*

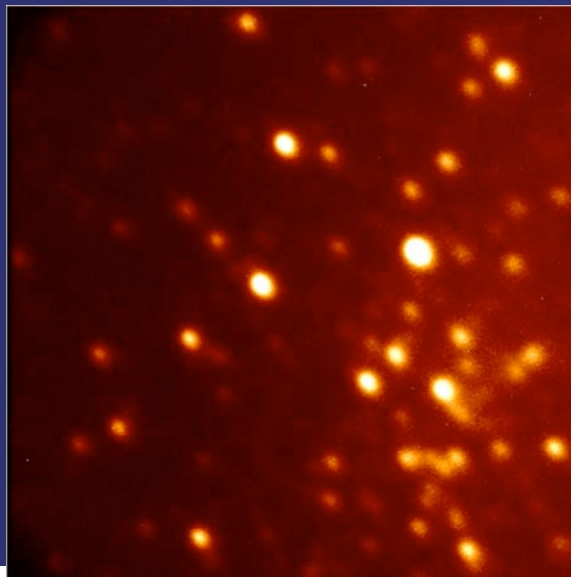


Broadband Filters

- *Filter wheel has 8 slots*
- *VRI filters*
- *3 polarizers*
- *The high quality CCD is uniform, and the focus is good across the whole field of view; thus GRBs need not be centered to obtain good data*



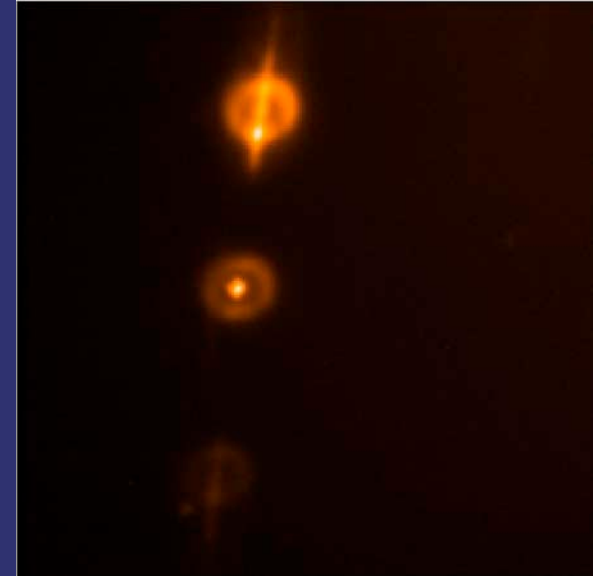
Raw V-band image of Saturn; 70 msec exposure time. The rings just fit into the full field of view.



I-band image of part of the globular cluster M79; 10 sec exposure time. The only processing was a dark current subtraction.

Imaging Spectroscopy

- *Final filter slots filled with a transmission grism and a transmission grating*
- *These give the spectra of all the objects in the field of view; thus the counterpart does not have to be identified before starting to do spectroscopic observations*
- *Coverage is 450 - 950 nm*



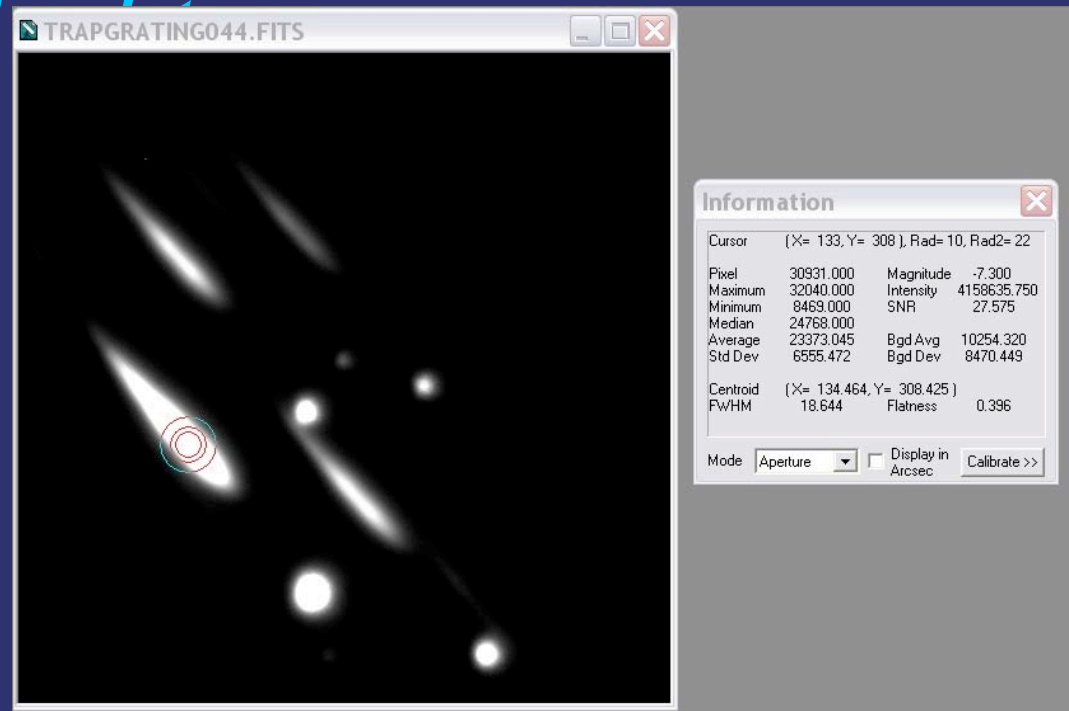
Grism image of Campbell's hydrogen envelope star; 2 sec exposure time. The only processing was a dark current subtraction. The dispersed ring is sharp because it is H α . The central star also has strong ionized carbon emission lines.

Operations

- *No internet access to the computer taking the data; the data has to be transferred later to an edu-accessible computer*
- *Operators are talked through the observations on the phone using simplified*

Raw grating image of the Trapezium stars in the Orion Nebula; 0.5 sec exposure time.

The operator is checking the spectrum to see if it is saturated.



Summary

- *AEOS and the RUCCD will hopefully nicely complement Swift*
- *The RUCCD is fully operational and calibrations are ongoing*
- *The RUCCD is certified to perform GRB ToO observations with a high priority override*
- *For a few bursts each year, we will be able to do rapid imaging, polarimetry, and/or spectroscopy using a large-aperture telescope*

For more details, see Smith, I. A. et al. 2004, AMOS Technical Conference proceedings.